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# A NEW SPECIES OF *DICERATHERIUM* FROM THE LOWER PLIOCENE (VALENTINIAN) OF BOYD COUNTY, NEBRASKA

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The presence or absence of rugose areas and convex bosses on the skull are characters useful in the identification of most genera and species of fossil rhinoceros. A rhinoceros skull, collected more than a decade ago from Pliocene sediments in Boyd County, Nebraska (University of Nebraska Collecting Locality Bd-6, the Joseph Jamber farm), is like *Diceratherium armatum* in these respects, but it differs in others. It resembles *Diceratherium* in the presence of very small, elongate, roughened areas on the nasals, but the occipital region of the skull is wide, as in *Peraceras*. In skull outline, the resemblance is to *Diceratherium*, but the teeth are like those of *Peraceras*.

Indeed, this skull for some years was tentatively considered to represent a new species of *Peraceras*, but it is now assigned to *Diceratherium* as the latest species of this genus in the Tertiary of the High Plains.

† † †

## INTRODUCTION

In 1965 the Pliocene deposits in Boyd County, Nebraska (University of Nebraska State Museum Locality Bd-6, the Joseph Jamber farm) yielded a nearly complete, well-preserved rhinoceros skull. Initially assigned to *Peraceras* (Tanner, 1976), this skull is here considered instead to represent a new species of *Diceratherium*.

The site, discovered and first worked by the author, has now become a quarry that has produced a large collection of fossil vertebrates—the Jamber local fauna—preserved in the University of Nebraska State Museum (U.N.S.M.).\*

The fossils other than the rhinoceros are to be reported upon chiefly by Karen and Charles Messenger, but they include the following: fish; anurans; turtle; snakes; the beaver, *Anchitheriomys*; other beavers, undetermined; a fox-like carnivore, *Leptocyon*; a wolf-like carnivore, *Aelurodon*; a mastodont, *Gomphotherium*; a browsing horse, *Hypohippus*; a

larger browsing horse, *Megahippus*; a grazing horse, *Hipparion*; a camel, *Procamelus*; another camel, undetermined; and a prong-horn, probably *Merycodus*. The assemblage and the stratigraphy indicate a Valentinian age (Schultz and Stout, 1961; Schultz, Martin, and Corner, 1975), considered as Pliocene.

## SYSTEMATICS

ORDER PERISSODACTYLA OWEN, 1848

Suborder Hippomorpha Wood, 1937

FAMILY RHINOCEROTIDAE OWEN, 1845

Subfamily Caenopinae Brunning, 1923

*Diceratherium* Marsh, 1875

*Diceratherium jamberi*, new species\*\*

Holotype.—U.N.S.M. 62048, a nearly complete skull, including nasals.

Type Locality.—Boyd County, Nebraska, 3.0 miles east and 4.5 miles south of Butte, in Sec. 7, T. 33 N., R. 21 W., in a quarry on the farm of Joseph Jamber (U.N.S.M. Collecting Locality Bd-6).

Geologic Occurrence.—Valentine Formation, probably upper part, possibly from an equivalent of the Burge Member: Valentinian (Pliocene).

Diagnosis.—The skull is relatively elongate, not saddle-shaped, but some measurements are about the same as for *Aphelops megalodus*. However, the occipital region is narrower and less elevated than for *Aphelops megalodus* (Table I), and the occipital crest is situated vertically with respect to the occipital condyles. The frontal region is only slightly lower than the anterior portion of the sagittal crest, and it is smooth, not convex. The brow areas are heavy and only slightly roughened. The nasals are not completely co-ossified, and they show small, elongate, elliptical ridges on each side, which are probably the bases for small horns. The ridges are posterior

\*Other abbreviations for institutions cited are: A.M.N.H., American Museum of Natural History (and F:AM, the Frick Collection), New York City; C.M., Carnegie Museum, Pittsburgh; U.S.N.M., United States National Museum, Washington, D.C.; and Y.P.M., Yale Peabody Museum, New Haven, Connecticut. Thanks are expressed to the officers of each of these collections for allowing me to study specimens in their charge.

\*\*Named for Joseph Jamber, to whom we are indebted for many courtesies.

to the tip of the nasals and similar to those on the holotype skull of *Diceratherium armatum* (Y.P.M. 10003).

The premaxillae are retracted and lack the alveoli for I 2/. The anterior openings of the infraorbital foramina are large and situated outside the narial opening, with only slight facial depressions below the foramina. The zygomata are deepest anterior to the mid-point of the arches. The postglenoid processes are relatively small and curved forward at the tips.

Dentition.—The teeth exhibit the following characters:

- P 1/, tooth relatively small, with well-developed parastyle; lacks both pre-fossette and post-fossette; protoloph swings posterad to join the lingual margin of the metaloph, which is short and wider than the protoloph; there is no buccal cingulum and only a trace of a lingual cingulum.
- P 2/, tooth larger than the P 1/; both pre-fossette and post-fossette are present; the protoloph and metaloph are nearly confluent; the lingual cingulum is strong, with a weak crochet, but there is only a trace of a buccal cingulum.
- P 3/, tooth larger than the P 2/, and nearly the same length as the P 4/; there is a post-fossette, a shallow, median valley, and both ante-crochet and crochet; the lingual cingulum has a slight crenulation at the opening of the median valley, and there is only a trace of the buccal cingulum, but it is situated posterad.
- P 4/, tooth nearly the same size as the M 1/ and M 2/; there is a post-fossette, the median valley is open, and the parastylar fold is weak; the lingual cingulum is strong, but the buccal cingulum is weak.
- M 1/, tooth nearly the same size as the M 2/ and P 4/; there is a post-fossette, the median valley is open, and both an ante-crochet and crochet are present; the lingual cingulum is interrupted by a median valley, and the buccal cingulum is weak.
- M 2/, tooth nearly the same size as the two preceding teeth; a post-fossette is present, the median valley is open and deep, and both the ante-crochet and crochet are weak, with the latter situated near the metaloph-ectoloph junction; the lingual cingulum is at the anterior side of the protoloph.
- M 3/, tooth smaller than the M 2/ and triangular; the median valley is open, and the crista is strong;

the parastylar fold is strongest on this tooth, but this is progressive from the P 4/; the lingual cingulum is at the anterior portion of the protoloph, but it is weak at the base of the metaloph.

Selected Measurements (see also Table I).—The distance from the anterior margin of the orbit to the posterior edge of the narial notch is 75 mm. for *Diceratherium jamberi*, compared to 62.5 mm. for *Aphelops megalodus* (A.M.N.H. 8292), 74 mm. for *Peraceras superciliosus* (A.M.N.H. 8380), and 88 mm. for *Peraceras troxelli* (A.M.N.H. 14434).

This measurement is usually greater than these values for both *Diceratherium* and *Menoceras*. It is 110 mm. for the holotype of *Metacaenopus egrigius* (A.M.N.H. 82591), probably best considered as a female *Menoceras*, and as much as 150 mm. for some of the very large skulls (F:AM) of *Diceratherium* from eastern Wyoming. However, the skull of *Menoceras marslandensis* (U.N.S.M. 62004) measures 90 mm. in this regard.

Taking a different measurement—the length of the free portion of the nasal from the narial notch to the tip of the nasal—we obtain a value of 107 mm. for *Diceratherium jamberi*, 116 mm. for *Diceratherium armatum* (U.S.N.M. 11682), and 178 mm. for *Aphelops montanus* (C.M. 1569). One, however, must establish a lineage-progression with a considerable number of specimens, so that age and sex factors, as well as individual variation, are reasonably well known.

## DISCUSSION

This skull was first considered by the author (Tanner, 1976) to represent a new species of *Peraceras*, but the assignment to *Diceratherium* is now preferred for the following reasons.

(1) *Peraceras* has a relatively brachycephalic, saddle-shaped skull, with the occipital region well-elevated above the frontal region and with both the occiput and the occipital crest inclined far forward with respect to a vertical plane rising from the occipital condyles. The skull of *Diceratherium* is more elongate, and the occiput as well as the occipital crests rise nearly vertically from the occipital condyles.

(2) *Diceratherium*, as its name indicates, had two, paired horns located toward the anterior end of the nasals. It is differentiated from its contemporary, *Menoceras* in several ways: by being slightly concave, not saddle-shaped in side-profile; with the narial notch above the P 1/ and not retracted; with nasal bosses that are elongate, elliptical ridges with a broad and relatively shallow palate; and with the length of the M 1/—M 3/ series approximately 250 mm. (Tanner 1969).

(3) The dental pattern of *Diceratherium* is relatively simple in the early forms of the lineage, but it seems

Table I:

Measurements in Millimeters of Three Rhinoceros Skulls:  
*Diceratherium jamberi*, New Species (U.N.S.M. 62048),  
*Aphelops megalodus* (A.M.N.H. 8292),  
and *Diceratherium armatum* (Y.P.M. 10003)

	U.N.S.M. 62048	A.M.N.H. 8292	Y.P.M. 10003
Occipital condyles to tip of premaxillary	-----	-----	-----
Occipital condyles to tips of nasals	470	495	(512)
Midpoint occipital crest to tips of nasals	453	451	(503)
Anterior margin of P <sup>1</sup> to occipital condyles	440	445	452
Narial notch to occipital crest	354	332	453
Palatal notch to foramen magnum	237	258	272
Palatal notch to palatal foramina	-----	-----	170
Narial notch to tips of nasals	107	163	-----
Zygomatic breadth (maximum)	277	-----	278
Width across palate to buccal sides M <sup>2</sup>	170	168	174
Orbital breadth (between notches)	152	145	210
Occipital height, base condyles to crest	162	181	159
Occipital width (maximum)	165	188	150
Condylar width (outer margins occ. condyles)	104	-----	107
Tooth row, P <sup>1</sup> —M <sup>3</sup> (midline, to rear of M <sup>3</sup> )	236	-----	254
Tooth row, P <sup>2</sup> —M <sup>3</sup> (midline, to rear of M <sup>3</sup> )	97	-----	-----
Premolars (midline)	120	-----	123
Length P <sup>2</sup> —P <sup>4</sup> (midline, to rear of P <sup>4</sup> )	-----	-----	95
Molars (midline, to rear of M <sup>3</sup> )	123	-----	133
Length P <sup>1</sup> (maximum)	23	22	27
Width P <sup>1</sup> (maximum)	20	18	23
Length P <sup>2</sup> (maximum)	29	28	27
Width P <sup>2</sup> (maximum)	39	36	37
Length P <sup>3</sup> (maximum)	32	31	33
Width P <sup>3</sup> (maximum)	48	48	43
Length P <sup>4</sup> (maximum)	33	34	31
Width P <sup>4</sup> (maximum)	57	53	47
Length M <sup>1</sup> (maximum)	40	41	47
Width M <sup>1</sup> (maximum)	55	55	52
Length M <sup>2</sup> (maximum)	45	40	50
Width M <sup>2</sup> (maximum)	53	52	56
Length M <sup>3</sup> (maximum)	35	47	37
Width M <sup>3</sup> (maximum)	49	52	47

( ) = estimated dimension

to become progressively more complicated. The teeth of *Diceratherium jamberi* are more complicated than for the holotype of *Diceratherium armatum*, especially in the presence of a well-developed crista on the upper third molar, lacking in *Diceratherium armatum*. However, a complicated tooth-pattern similar to that found in both *Peraceras* and *Aphelops* is seen in *Diceratherium jamberi*.

(4) There seem to be few affinities of *Diceratherium jamberi* with the *Teleoceras* lineage, for *Teleoceras major* has more hypsodont teeth and the third upper molar is much longer.

These considerations are suggestive of a close relationship, possibly an ancestral-descendant one, between the *Diceratherium* and *Peraceras* lineages, but at present this can be only an hypothesis.

#### ACKNOWLEDGMENTS

Thanks are extended to Joseph Jamber and his family of Boyd County, Nebraska, for permission to excavate the fossil quarry on their farm, and for other help. Examination of comparative rhinoceros material, particularly of *Diceratherium*, was facilitated due to the cooperation of Richard Tedford, Malcolm McKenna, Earl Manning, and Morris Skinner at the American Museum of Natural History. C. Bertrand Schultz, T.M. Stout, and Michael Voorhies gave helpful suggestions. Other much-appreciated assistance was given by George Corner, Karen and Charles Messenger, Martha Haack, Rebecca Monke, and especially by my wife, Mary.

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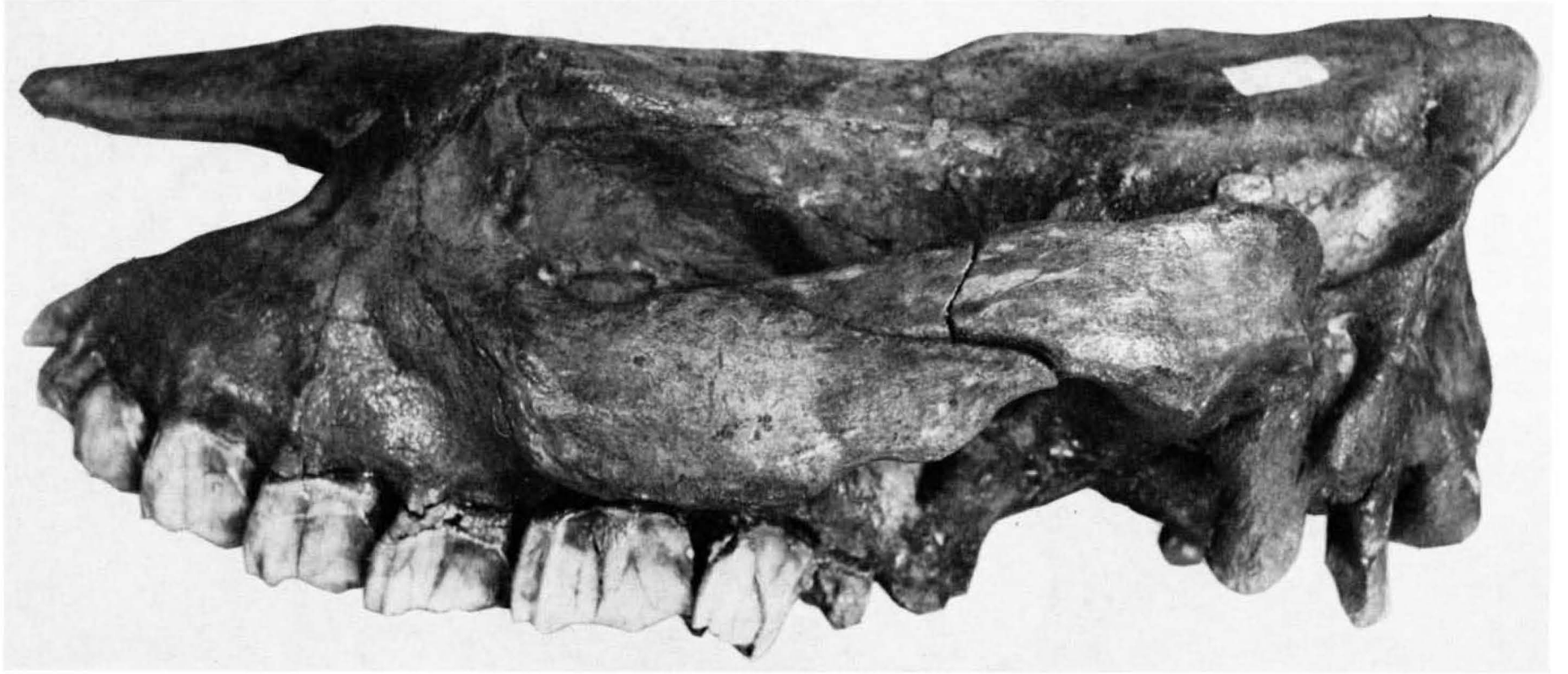


Figure 1. Lateral view of holotype skull (U.N.S.M. 62048) *Diceratherium jambori* n. sp. X 2/5.

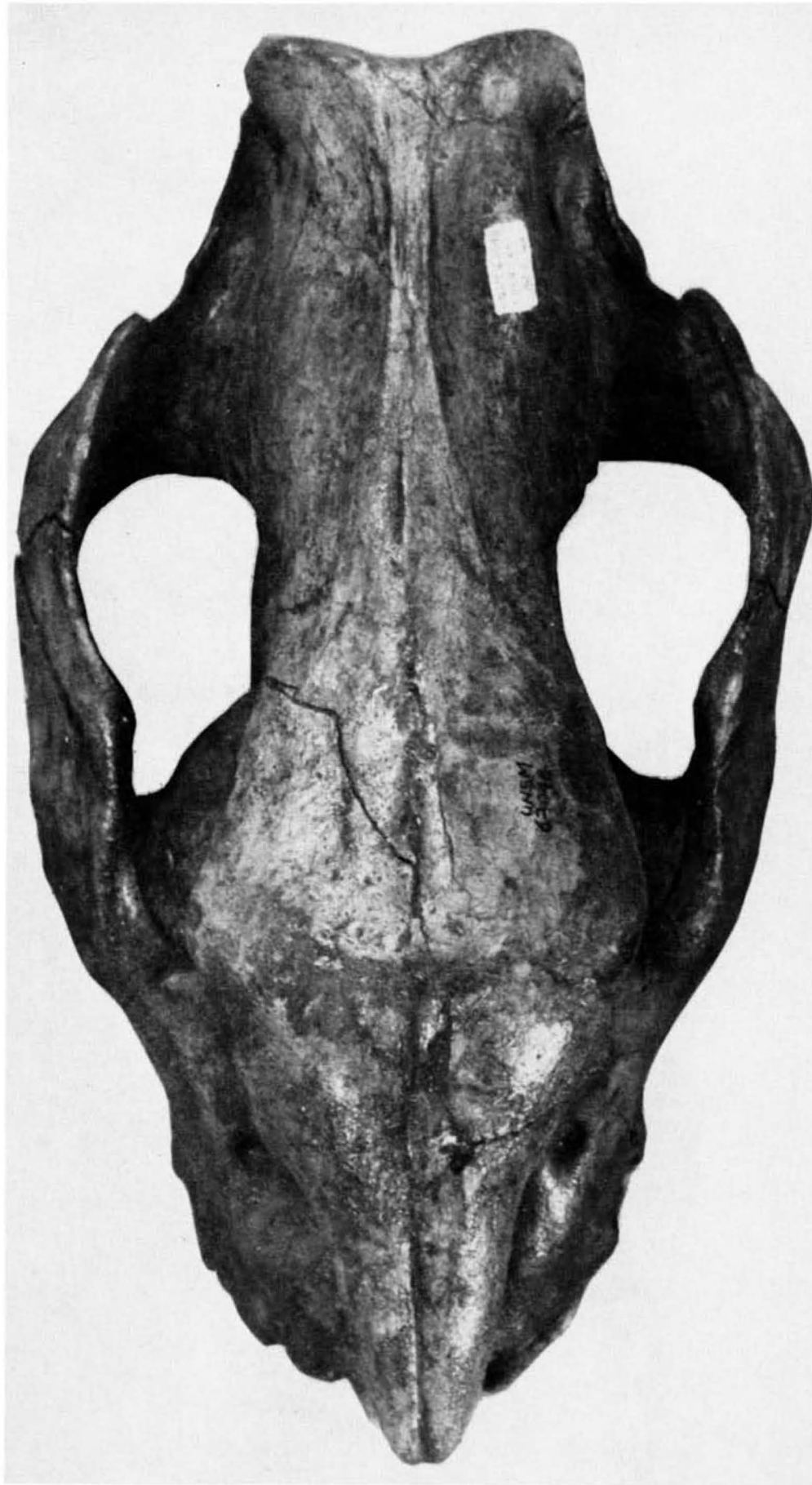


Figure 2. Dorsal view of same skull as shown in Fig. 1. X 2/5.



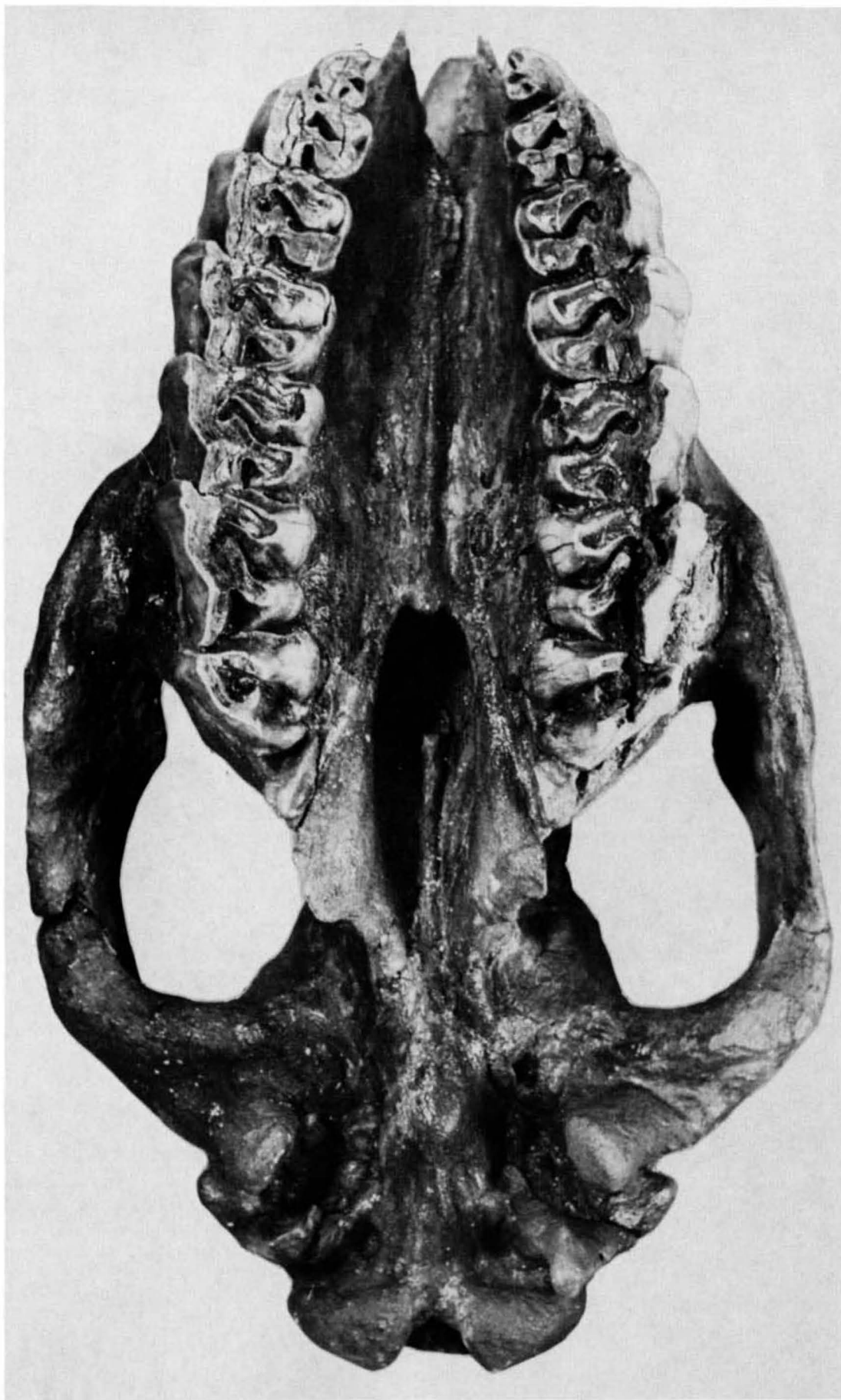


Figure 3. Palatal view of same skull as shown in Fig. 1. X 2/5.



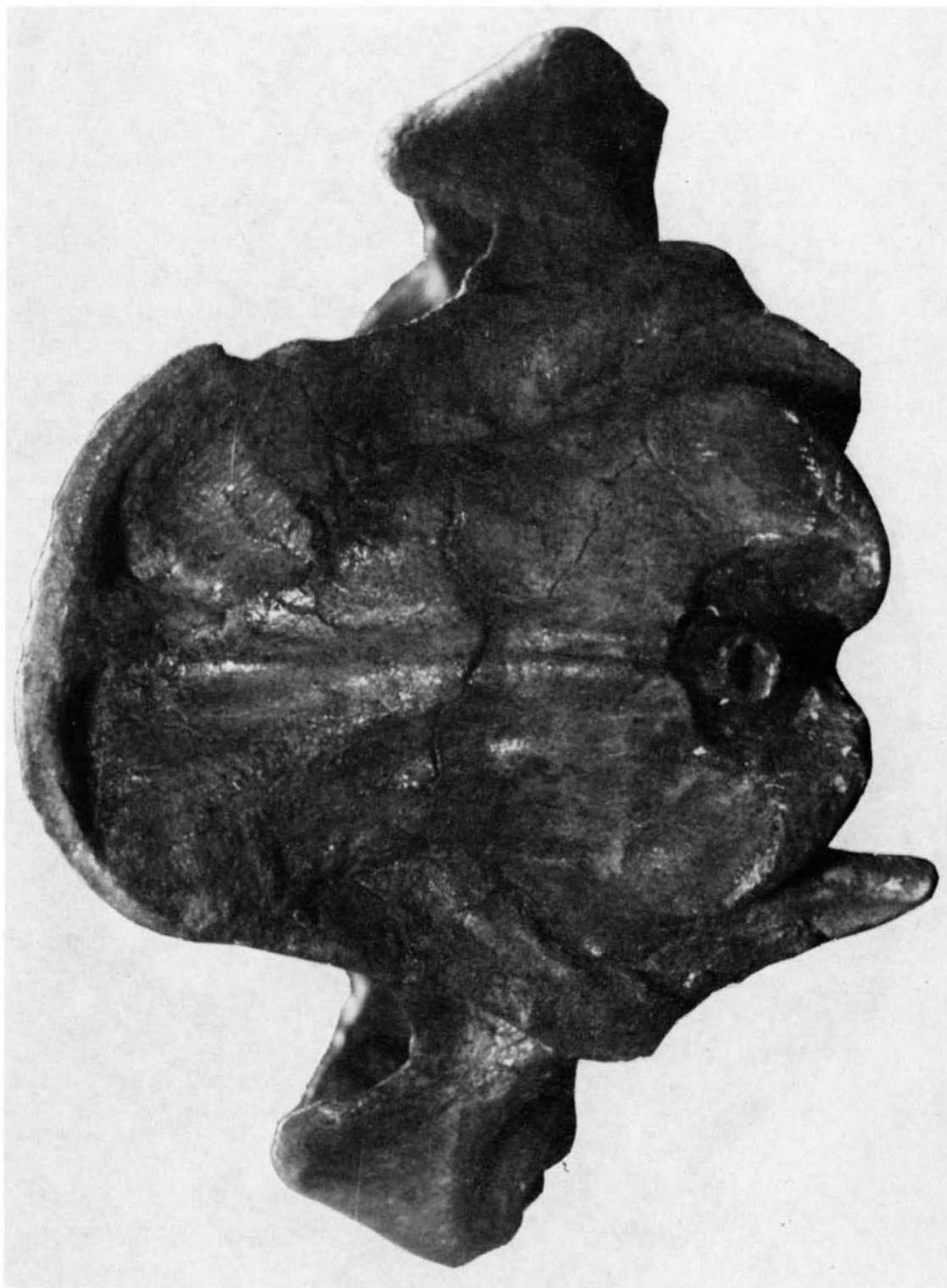


Figure 4. Occipital view of same skull as shown in Fig. 1. X  $3/4$ .

# FOSSIL MOLES OF LATE HEMPHILLIAN AGE FROM NORTHEASTERN NEBRASKA

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Disarticulated remains of more than thirty fossil moles (Insectivora: Talpidae) have been recovered by washing alluvial sediments of late Hemphillian age near Santee in northern Knox County, Nebraska. A fission-track age (on glass) of  $5.0 \pm 0.2$  million years before present has been determined for an ash lying stratigraphically above the fossiliferous stratum (Boellstorff, 1976).

Four distinct talpid taxa are represented in the sample (based on differences in humeri), but over 98% of the material pertains to a single species of highly specialized burrowing mole allied to *Scalopus* (*Hesperoscalops*) *sewardensis* K.M. Reed. A new species of *Hesperoscalops*, differing from the two previously known species by its larger size and heavier development of cingular cusps, is named on the basis of the new material. Examples of all upper and lower cheek teeth and most major limb bones are described. A digging ability equalling or exceeding that of Recent *Scalopus* (*Scalopus*) *aquaticus* is suggested for the new species on the basis of its brachial morphology. The new material supports Hutchison's (1968) view that *Hesperoscalops* is best considered a subgenus of *Scalopus*. The remaining taxa, represented by humeri only, consist of the following:

- (1) a very small, highly specialized fossorial mole of *Scalopus*-grade;
- (2) a large mole with a humerus approaching that of *Parascalops* but larger than the living species; and
- (3) a small, moderately fossorial mole resembling *Scalopoides* in humeral morphology.

† † †

## INTRODUCTION

Remains of moles are not uncommon in vertebrate fossil assemblages of Arikarean through Barstovian age in the Great Plains, but they have been noted infrequently in later Tertiary deposits of the area (see historical review in Hutchison, 1968). My purpose here is to describe a more adequate sample of Great Plains Hemphillian talpids than has previously been available. The specimens, although fragmentary, provide evidence for the existence of a relatively diverse mole fauna (four species) on the plains, approximately 5 million years ago. Remains of one of the species are sufficiently distinct and complete to warrant recognition as a new species of the extinct subgenus of highly fossorial talpid, *Hesperoscalops*. A minimum of 30 individuals is represented in the sample which includes well preserved examples of the lower jaw, maxilla, humerus, ulna, and radius as well as all upper and lower molars. Hutchison's (1968) suggestion that *Hesperoscalops* should be regarded as a subgenus of *Scalopus* is

reinforced by the present study as is Hibbard's (1964) view (*contra* K.M. Reed, 1962) that *Scalopus* (*Hesperoscalops*) *sewardensis* may be ancestral to *S. (H.) rexroadi*. A review of the evidence now available suggests that the *Scalopus* lineage was well established on the Great Plains by Hemphillian time and that populations of these highly fossorial moles have evolved *in situ* since then. Trends toward 1) decrease in size and 2) reduction in cingular cusps on the molars are evident in the following progression from oldest to youngest: *Scalopus* (*Hesperoscalops*) n. sp. (this paper)—late Hemphillian; *S. (H.) sewardensis* (K.M. Reed, 1962)—latest Hemphillian/earliest Blancan; *S. (H.) rexroadi* (Hibbard, 1941)—early Blancan; *S. (S.) aquaticus*—Pleistocene and Recent.

The present paper also calls attention to the existence of alluvial sediments of Hemphillian age within the glaciated region of northeastern Nebraska. These deposits have only recently received attention from geologists and paleontologists. Rather extensive collections of mammalian and other vertebrate fossils from these strata are being assembled by field parties from the Nebraska State Museum and taxonomic studies of several groups by the writer and others are underway. The presence of radiometrically datable volcanic ash beds interlayered with the fossiliferous alluvial sediments is particularly fortunate.

## GEOGRAPHIC AND GEOLOGIC SETTING

A succession of stream channel deposits confined to three or more paleovalley systems of Hemphillian age occur in Knox, Antelope, and Holt counties in northeastern Nebraska. Detailed mapping of these paleovalley systems will require subsurface studies far beyond the scope of the present paper. A brief description of a cross section of one of these channel fills will suffice for present purposes. This channel-fill is exposed in a series of roadcuts between 1.9 miles and 3.5 miles south of the village of Santee in northern Knox County, just south of the Missouri River. Unfortunately, detailed topographic maps are not yet available for the area, so only an approximate location may be given. As determined from the 1955 USGS Sioux City (Iowa, Nebr., S. Dakota) Transverse-Mercator-Projection Map, the principal roadcut lies in the NE¼, NW¼, sec. 25, T33N, R5W at an elevation between 1500 and 1600 feet.

The stratigraphic relationships at the Santee roadcut (University of Nebraska State Museum [U.N.S.M.] locality Kx-111) are shown in Figure 1. A black (weathering to orange-brown) marine shale of Cretaceous age—the Pierre Shale—locally makes up the pre-Tertiary bedrock as it does throughout most of northeastern and north-central Nebraska. It is disconformably overlain by unconsolidated sand with lenses of lithic gravel and clay. The erosional surface at the top of the Pierre Shale descends abruptly toward the south, suggesting that the outcrop lies at the northern edge of a paleovalley which was filled with alluvial sediment. Bedding within the channel-fill is steeply inclined, mostly toward the south, with successively younger sets of inclined beds overlapping each other toward the south. Locally at least, a southward-migrating stream system was responsible for depositing the channel-fill.

Farther south, particularly at a roadcut 3.5 miles south of Santee near the center of sec. 35, T33N, R5W, the upper portion of the channel-fill is exposed. Here the sand and gravel occurring at the lower contact of the channel-fill at Kx-111 may be seen passing gradationally upward into horizontally bedded silt and very fine sand. A distinctive white volcanic ash lying within this finer-textured upper portion of the sequence has been dated at  $5.0 \pm 0.2$  million years before present by the fission track method (Boellstorff, 1976). Although less common than in the lower, coarser part of the channel-fill, Hemphillian vertebrate fossils taxonomically identical to those at Kx-111 have been found in the roadcut from which the dated ash sample was taken.

The relationship between the channel-fill and earlier Tertiary rocks cannot be directly observed in the Santee area because the unit rests directly on Cretaceous bedrock. Two lines of evidence, however, show that post-Clarendonian and pre-late Hemphillian erosion removed the Valentine Formation and Caprock Member of the Ash Hollow Formation (Skinner, Skinner, and Gooris, 1968) which were probably continuous over the area originally. 1) Outcrops of the Valentine Formation and overlying Caprock have been recognized both east and west of the Santee area in Knox County (Voorhies, 1971, 1973). 2) Fragments of rock types distinctive of the Valentine and Caprock occur as clasts in the gravelly sand lenses at Kx-111, especially near the base of the channel (Fig. 1). Most notable of these clasts are fragments of green orthoquartzite, which are found abundantly in the Valentine, and calcite-cemented sandstone with abundant siliceous tubules, which is characteristic of the Caprock (Skinner, Skinner, and Gooris, 1968, Figs. 2-4). A particularly distinctive feature of the channel-fill at Santee, and also of other late-Hemphillian channels in northeastern Nebraska, is the great abundance of silicified rootlets and horsetail rush (*Equisetum*) stem fragments in the gravel lenses. This fossil plant debris is usually much abraded and is certainly reworked from pre-existing sediments, probably largely from the Caprock in which similar root and stem material is locally abundant *in situ*. A further characteristic of the pebble- and cobble-sized clasts in the

exposure at Kx-111 and other Hemphillian channels in northeastern Nebraska is the absence of crystalline igneous and metamorphic rock types. In sharp contrast, the gravel fraction of Blacan and Pleistocene deposits in this area is predominantly crystalline (Stanley and Wayne, 1972).

The alluvial channel-fill sediments at Kx-111 cannot be assigned to any formally named lithologic unit known to me. Perhaps eventually they will be referred to as a new formation but such a step would require areal and subsurface mapping far beyond the scope of the present study. The deposits are clearly not referable to the Ash Hollow or Kimball formations which have yielded fossils of Hemphillian age in southwestern Nebraska. Crystalline gravel makes up a significant proportion of these units (Stout *et al.*, 1971; Breyer, 1975). For the present, therefore, the beds yielding the Santee local fauna are best left unnamed.

## NATURE OF THE SAMPLE

The fossils studied were recovered by washing approximately two tons of unconsolidated gravelly sand through boxes of 16-mesh screen and carefully picking all fossils from the resulting residue. The sediment was obtained from a 2-foot-thick, cross-stratified unit identified by the informal term "squirrel lens" in Figure 1. Most of the fossils are somewhat broken and abraded, but, in general, preservation is good, the bone being extensively permineralized and of a mottled grey or brown color. As might be expected in a channel deposit, fossils reworked from older beds are not uncommon at the Santee exposure. In the coarse rubble at the base of the channel occur shark teeth and mosasaur vertebrae, probably derived from the underlying Pierre Shale. Some partial horse teeth and merycodont horn fragments resemble specimens indigenous to the Valentine Formation. These probably were derived from the Valentine along with the pebbles and cobbles of green orthoquartzite reworked from this unit, as discussed above.

Sampling at 3-foot intervals up the exposure showed that the abundance of reworked fossils decreased markedly above the channel base. No obviously reworked specimens were detected in the two-ton sample from "squirrel lens." The fossil insectivore and rodent material from this sample so far studied by the writer show no more intraspecific variability than that encountered within a similarly sized collection of Recent small mammals from a single locality. The conclusion seems warranted, therefore, that the fossils constitute a "local fauna" as the term is usually understood by vertebrate paleontologists (see discussion in Tedford, 1970).

## AGE OF THE SANTEE LOCAL FAUNA

The fission-track date of  $5.0 \pm 0.2$  m.y. on an ash overlying the beds that yield the Santee local fauna accords well with a date of  $5.3 \pm 0.4$  on an ash overlying the "type

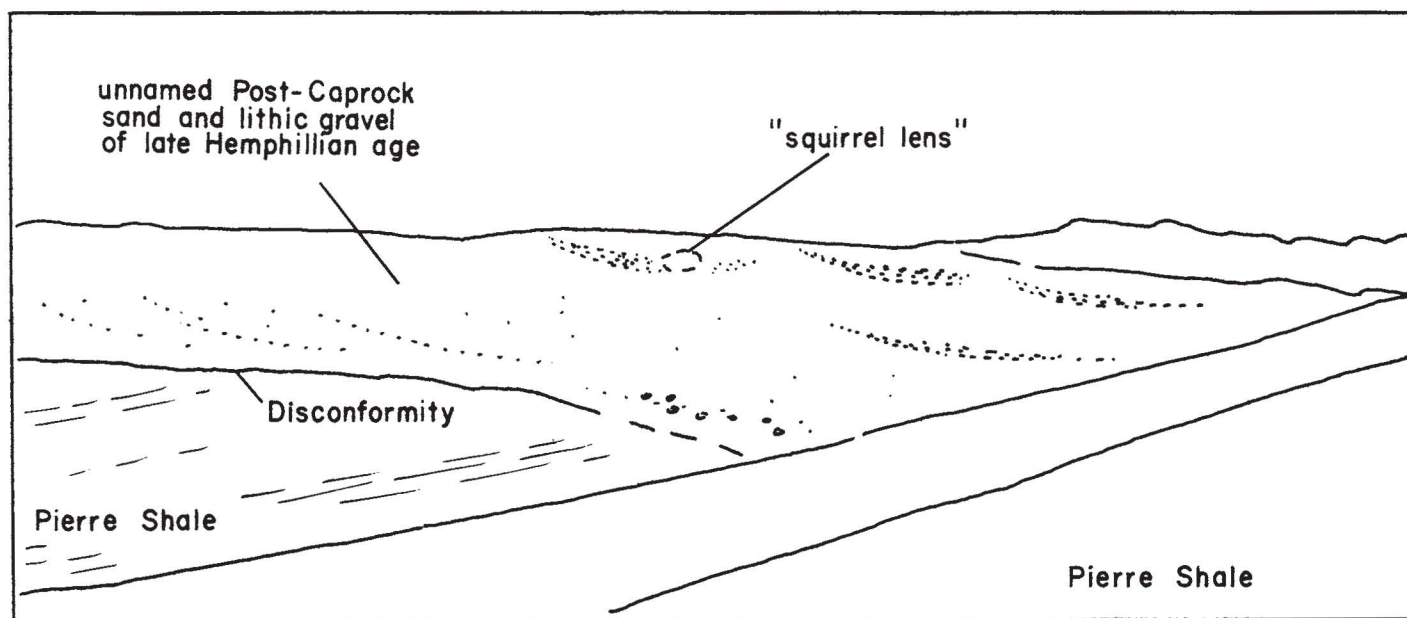
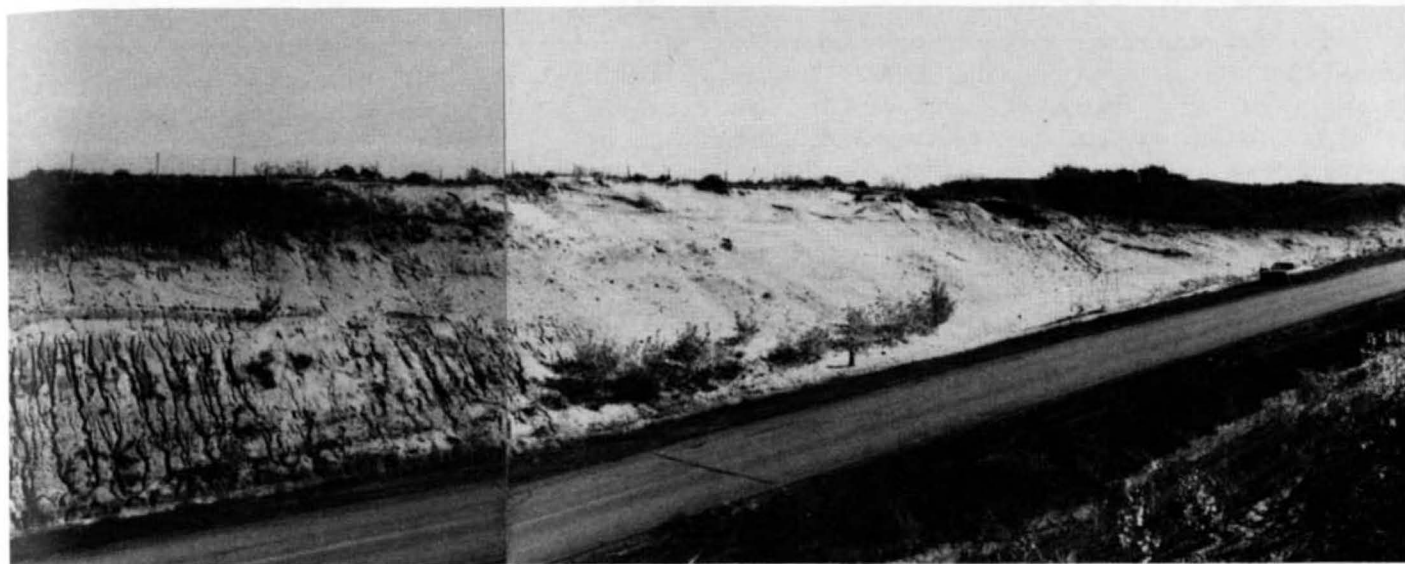


Figure 1. Looking southeastward at U.N.S.M. locality Kx-111 in northern Knox County, Nebraska. Fossils comprising the Santee local fauna were collected from the unnamed post-Caprock channel-fill well exposed in the roadcut. A scour surface of considerable relief has developed on the Pierre Shale; note that it deepens progressively toward the South (right). The channel fill consists of unconsolidated fine to medium sand with interbedded lenses of gravel consisting of sedimentary rock fragments and silicified root casts. The holotype and all referred specimens of *Scalopus* (*Hesperoscalops*) *mcgrewi* n. sp. were obtained by washing approximately two tons of gravelly sand from the depositional unit informally termed "squirrel lens" at the place indicated.



fauna" of the Hemphillian at Coffee Ranch, Texas (Boellstorff, 1976) and with similar dates on correlative faunas obtained by Evernden *et al.* (1964) using the potassium-argon method.

The joint occurrence of mylagaulid rodents, *Dipoides*, rhinoceroses and megalonychid sloths at Kx-111 firmly establishes its age as Hemphillian, as discussed by Wood *et al.* (1941). Only one fossil specimen has previously been described from the Santee exposure, a referred specimen of *Propliophenacomys parkeri*, a primitive arvicoline (Martin, 1975:106). As pointed out by Martin, *P. parkeri* is similar to, but more primitive than, the early Blancan genera *Pliophenocomys* and *Pliolemmus*. On the basis of the fossil mole material described below, I believe the Santee local fauna is slightly older than the Saw Rock Canyon local fauna which "probably is late Hemphillian" (Schultz, Tanner, and Martin, 1972:184).

## SYSTEMATIC PALEONTOLOGY

### ORDER INSECTIVORA

#### FAMILY TALPIDAE

##### Subfamily Talpinae

#### TRIBE SCALOPINI

##### Subtribe Scalopina

genus *Scalopus* E. Geoffroy Saint Hilaire 1803

subgenus *Hesperoscalops* Hibbard 1941

*Scalopus (Hesperoscalops) mcgrewi* n. sp. (Fig. 2)

Type.—U.N.S.M. 51700, right mandibular ramus with P/4—M/3.

Hypodigm.—U.N.S.M. 51701–51705, U.N.S.M. 51707, U.N.S.M. 51710, U.N.S.M. 51713, U.N.S.M. 51714, U.N.S.M. 51699, lower teeth and partial mandibles including five M/1's, four M/1's and two M/3's; U.N.S.M. 51706, U.N.S.M. 51720, U.N.S.M. 51688, U.N.S.M. 51692, U.N.S.M. 51693, upper teeth and partial maxillae including five M1's, six M2's, and two M3's; U.N.S.M. 51747–51766, U.N.S.M. 51786–51795, U.N.S.M. 51800, 31 right humeri; U.N.S.M. 51767–51785, 19 left humeri; U.N.S.M. 51723, U.N.S.M. 51726–51729, five complete radii, U.N.S.M. 51734–51746, three complete and eleven partial ulnae; U.N.S.M. 51733, distal end of tibia; U.N.S.M. 51724, right metacarpal III; U.N.S.M. 51732, right metacarpal II; U.N.S.M. 51731, left proximal phalanx II. All from type locality.

Type Locality and Lithic Unit.—University of Nebraska State Museum locality Kx-111, Santee locality, 1.9 miles south of Santee in NE¼, NW¼, sec. 25, T33N, R5W, Knox County, Nebraska. Type and hypodigm collected from lens of lithic gravel approximately 30 feet above base of unnamed post-Caprock channel-fill.

Age.—Late Hemphillian, approximately 5 million years before present.

Etymology.—For Dr. Paul O. McGrew, in gratitude and admiration.

Diagnosis.—Large scalopine mole with dental formula:

$$\frac{? \cdot 1 \cdot 3 \cdot 3}{2(3) \cdot 1 \cdot 3 \cdot 3}$$

Larger than *Scalopus (Hesperoscalops) sewardensis* and *S. (H.) rexroadi* (molars at least 20% longer) and cingular cusps much more prominent, that on M/3 forming a distinct shelf approximately as long as the trigonid.

Description.—A right maxillary fragment, U.N.S.M. 51720, including M2/ and the alveoli of M1/, C, and P2/—P4/, differs little from the equivalent region in Recent *Scalopus (Scalopus) aquaticus* except for the considerably smaller size of the latter. The fossil shows a well-defined ridge for the insertion of m. masseter running from the ventral root of the zygoma to a point above the anterior extremity of M1/ much as in *S. (S.) aquaticus*. The excavation of the face anterior to the infraorbital foramen, however, is less pronounced in the fossil than in any of the 25 skulls of *S. (S.) aquaticus* examined by the writer.

No upper antemolars are present in the sample, but relative alveolar sizes show that the premolars were graded in size from P4/ (largest) to P2/ (smallest) with a larger tooth anterior to P2/ as in *S. (S.) aquaticus*. I follow Ziegler (1971) in regarding this tooth as the canine, P1/ having been lost. As noted by Hibbard (1953) in a maxilla of *S. (H.) rexroadi*, the upper cheek teeth in U.N.S.M. 51720 are very closely spaced in contrast to the wide spacing of these teeth which is a consistent feature of *S. (S.) aquaticus*.

Both the upper and lower molars are fully hypsodont (crown height/length > 1.0; enamel concealed beneath alveolar rim in early wear stages; os cementum extensively developed).

There are five M1/'s in the sample. They are fundamentally similar to homologous teeth in *S. (S.) aquaticus* but all possess a distinct parastyle which is lacking in the Recent species. In the fossil, mesostyle I (in Hibbard's, 1953, terminology) arises gradually from the crista, extending posterolabially from the paracone, and is not separated from the latter by a distinct notch as it is in the Recent species. In this, the M1/ of the new species resembles that of *H. rexroadi* as described and figured by Hibbard (1941, 1953). Likewise, the notch separating mesostyles I and II is much shallower in the fossil than in the Recent *Scalopus*. The valley separating mesostyle II from the metastyle is broad and deep in *S. (H.) mcgrewi* as in *S. (H.) rexroadi* (Hibbard, 1953:23) rather than narrow and restricted as in *S. (S.) aquaticus*. Upper molars of *S. (H.) sewardensis* are not known. Small but distinct posterolabial cingular cusps occur in all *S. (H.) mcgrewi*

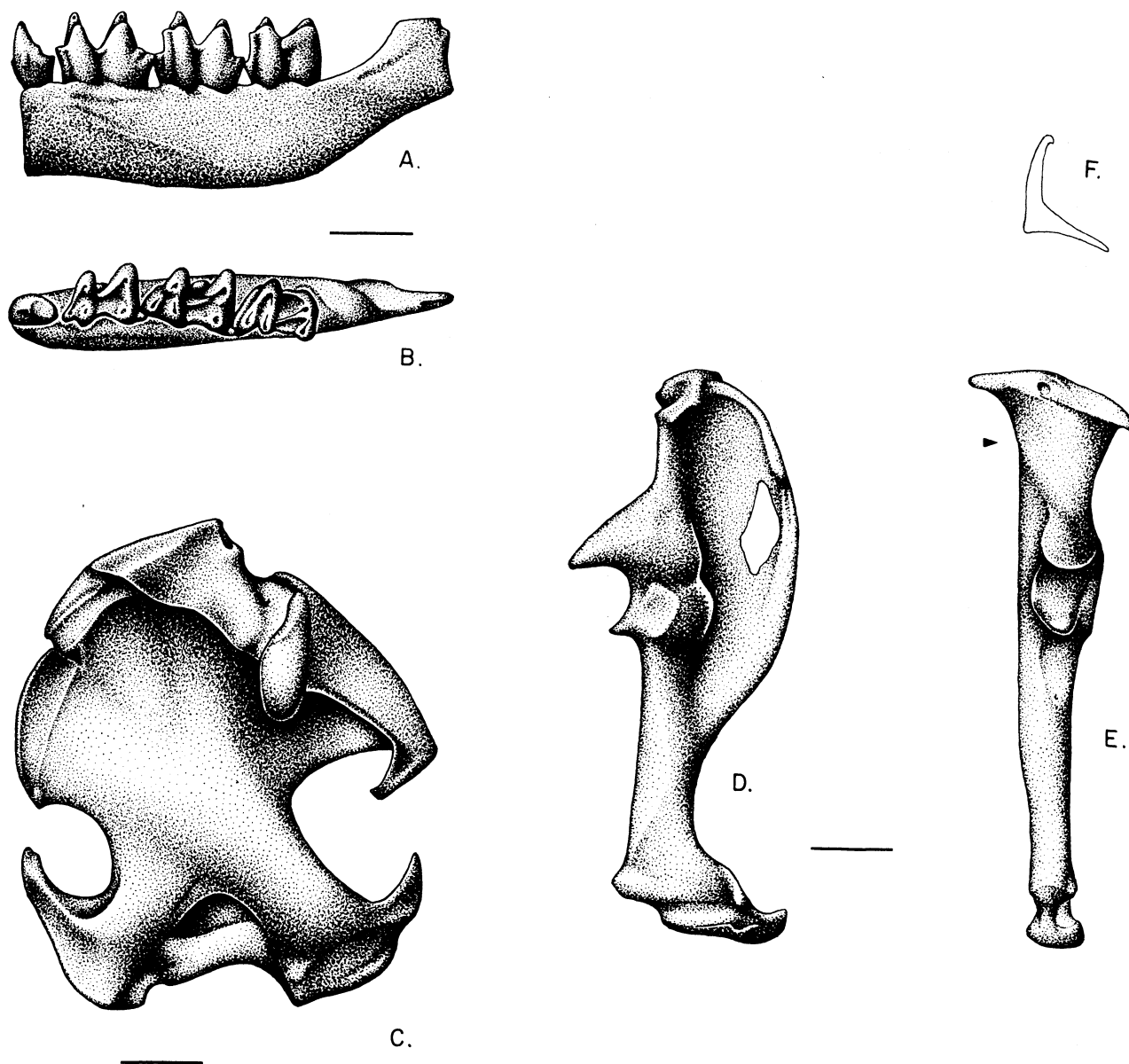


Figure 2. *Scalopus (Hesperoscalops) mcgrewi* n. sp. from the Santee local fauna, late Hemphillian, Knox Co., Nebraska.

- A. Holotype right ramus, U.N.S.M. 51700, lingual view.
- B. Same, occlusal view.
- C. Right humerus, U.N.S.M. 51800, posterior view.
- D. Left ulna, U.N.S.M. 51802, lateral view.
- E. Same, anterior view.
- F. Cross section of same at site marked.

Drawn by Martha Haack. Line = 3 mm.



M1/'s but not in other species. A small cuspule arising from the protocone partially blocks the lingual valley (protofossa) in all specimens of *S. (H.) mcgrewi*.

Six M2/'s are sufficiently well preserved to be described. As in M1/, the teeth are larger but similar to those of *S. (S.) aquaticus* in overall appearance. They are distinct, however, in the invariable presence of prominent anterior and posterior labial cingular cusps and of broadly open parastyle-mesostyle and mesostyle-metastyle valleys. The small cusp noted above on the protocone of M1/ is also present on M2/. Also as in M1/, the cleft dividing the mesostyle into two parts is much less persistent in the fossil than in the Recent species.

The M3/ resembles that of *S. (S.) aquaticus* but has a more broadly open, parastyle-mesostyle valley, an almost undivided mesostyle, and complete closure of the protofossa by a crista running from the protocone to the cingulum at the lingual base of the metacone. No M3/'s of other *Hesperoscalops* species have been reported.

Maximum anteroposterior diameters (ectoloph lengths) of upper molars are 3.50–3.70 (mean 3.58) for three M1/'s; 3.30–3.50 (mean 3.38) for four M2/'s; and 2.75 for an M3/. (All measurements are in millimeters).

Three mandibular rami are sufficiently complete to reveal the lower dental formula of the new species. Antemolar alveoli in U.N.S.M. 51713 and U.N.S.M. 51801 show that two incisors, a canine, and three premolars were present as in *S. (H.) rexroadi* (Hibbard, 1953) and in most individuals of Recent *S. (S.) aquaticus*. The "missing teeth" are assumed to be I/3 and P/1 following Conaway and Landry (1958) and Ziegler (1971). In a third specimen, U.N.S.M. 51704, however, a small alveolus is present just anterolabial to that identified as the canine alveolus; presumably this held a vestigial I/3.

P/4 is represented only in the type. Like the molars, it is a unilaterally hypsodont tooth with the labial portion of the enamel-covered crown curving beneath the alveolar border of the jaw. Strong anterior and posterior cingula are connected to the apex of the tooth by sharp ridges. The latter define the slightly concave labial surface of the tooth. P/4 resembles that of *S. (H.) rexroadi* as figured by Hibbard (1953) except for the strong anterior cingulum.

The molars are essentially as in *S. (H.) rexroadi* and *S. (H.) seawardensis* except for larger size (Table I and Fig. 3) and stronger development of basal accessory cusps. Also, cement is present on both the lingual and labial portions of the molar crowns in *S. (H.) mcgrewi*, while it is absent on the lingual side in *S. (H.) rexroadi* according to Hibbard (1953:22). In members of the subgenus *Hesperoscalops*, the molar trigonids are anteroposteriorly compressed, compared with those in *Scalopus (Scalopus)*. The compression in the new species is more extreme than that in other described species.

The trigonid compression and, to a lesser extent, talonid compression in *Hesperoscalops* are responsible for a widening of the hypoflexid, i.e., it approaches a U-shape in contrast with the V-shaped hypoflexid of Recent *Scalopus*. The hypoflexid in the new species is occupied by a large, shelf-like cusp which plays an active role in molar occlusion as indicated by wear facets. This cusp is present but much weaker in *S. (H.) seawardensis*, variably present in *S. (H.) rexroadi* and *S. (S.) aquaticus* (see Fig. 1 in Hibbard, 1953).

The humerus is represented by no fewer than 50 examples in the collection. Most are somewhat abraded, but several are nearly perfect. The humerus of *S. (H.) mcgrewi* is larger than, but strongly resembles, that of *S. (S.) aquaticus*, differing only in detail. The brachialis fossa is exceedingly deep as in the Recent species, but in posterior view, the medial margin of the fossa appears less distinct because the sharp ridge running distolaterally from directly beneath the head in the Recent form is weak-to-absent in the fossil.

The radius is represented in the sample by four complete specimens. Except for larger size, they closely resemble radii of Recent *Scalopus*. The specimens range from 13.40 to 14.25 in extreme length, from 11.05 to 11.85 in shaft length, and from 6.00 to 6.75 in distal width. Tendinal scars similar in placement to those of *S. (S.) aquaticus* are present but are much more prominent. The dorsolateral surface is marked by well-defined scars for retaining the ligament for the tendon of *M. extensor carpi radialis*. The lateral surface is crossed by an extremely well-developed groove for the passage of *M. abductor pollicis*, as in Recent *Scalopus* and other strongly fossorial moles, but the groove is much stronger than that in any Recent material examined by me.

A notable distinction between the new species and Recent *S. (S.) aquaticus* can be seen in the ulna, which is well represented in the Santee sample. *S. (H.) mcgrewi* ulnae have a well-developed medial olecranon crest, a feature found by Hutchison (1968:29) to be present in all talpids except modern *Scalopus*. Presumably this is a derived character in *Scalopus (Scalopus)* not yet present in *Scalopus (Hesperoscalops)*. Additionally, a much larger triceps scar occupies the proximal crest in the new species than is the case in Recent *Scalopus* ulnae. In lateral view, the semilunar notch describes a slightly more open semicircle in the Santee species than in Recent *Scalopus*, resembling *Scapanus* in this respect (Hutchison, 1968:28).

The known metacarpals and phalanges of the new species are, like those of *S. (S.) aquaticus*, extremely fore-shortened. Larger size and more pronounced tendinal attachments are the only features separating the former from the latter. Much the same can be said for the tibia, only the distal end of which has yet been recovered.

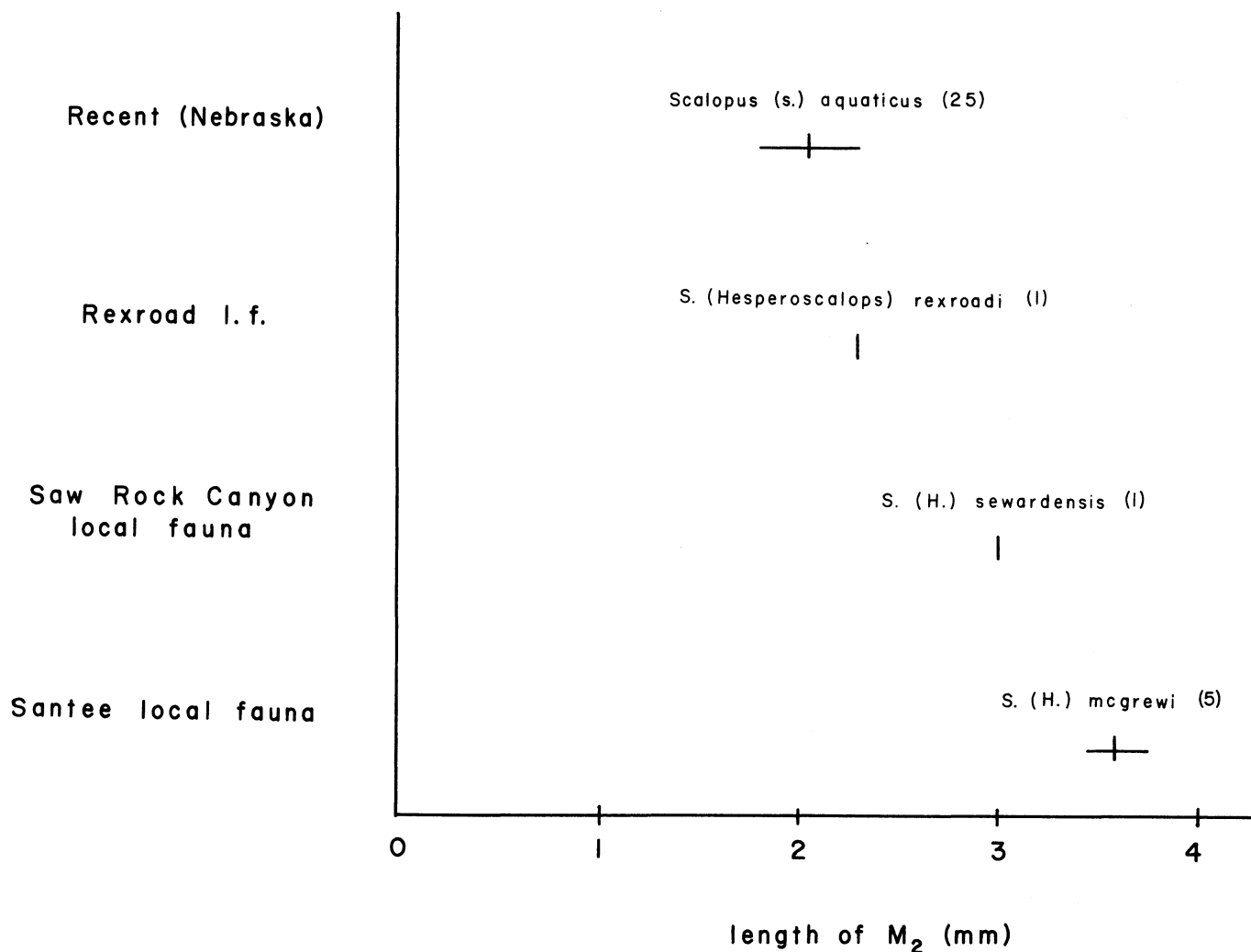


Figure 3. Variation in the length of the second lower molar in the known species of *Scalopus*. Horizontal line represents the observed range; vertical line is sample mean; number in parentheses is sample size. Measurements of *S. (H.) sewardensis* and *S. (H.) rexroadi* are from K.M. Reed (1962).

## DISCUSSION

Progressive shortening of the distal elements of the talpid forelimb in more fossorial species has been noted by many workers (e.g., C.A. Reed, 1951:550). As Reed states "the mole has sacrificed speed for strength, with obvious advantages to its mode of life." One index to the degree of fossorial adaptation in moles is the ratio of radius shaft length to humerus length. The mean length of four complete humeri referred to *S. (H.) mcgrewi* is 17.5 (range 16.5 to 18.0) while the shaft length of the four radii given above is 11.5, yielding a humero-radial ratio of 1.52. Five specimens of Recent *S. (S.) aquaticus* measured by the writer displayed an almost identical ratio: humerus length (14.9) / radius shaft length (9.9) = 1.51. Shortening of the forearm in *Scalopus* had thus reached the modern condition by late Hemphillian time. *S. (H.) mcgrewi* was apparently a powerful digger and probably spent virtually its entire life underground, as does its modern relative.

cf. *Scalopus* sp.

A right humerus (U.N.S.M. 51799) is very similar to humeri of *Scalopus (Hesperoscalops) mcgrewi* but is much smaller (length 8.2). The specimen is both broken and abraded, so the measurement given is a minimum, but even allowing for postmortal size reduction by stream wear, the bone is much smaller than humeri of the larger species that have suffered equivalent damage. A high degree of fossorial adaptation is indicated by the great breadth of the specimen relative to its width. An otherwise unknown species of small scalopine talpid comparable to *Scalopus* in evolutionary grade appears to be represented by the specimen.

Table I:

Measurements (mm) of Lower Dentition of *Scalopus (Hesperoscalops) mcgrewi* n. sp.  
From U.N.S.M. Locality Kx-111 (Santee Local Fauna) Late Hemphillian, Northeastern Nebraska

	P/4		M/1		M/2		M/3	
	AP	TR	AP	TR	AP	TR	AP	TR
U.N.S.M. 51700 (Type)	1.60	1.30	3.50	2.45	3.50	2.50	2.95	2.20
U.N.S.M. 51701	---	---	---	---	---	---	3.00	2.15
U.N.S.M. 51702	---	---	---	2.45	---	---	---	---
U.N.S.M. 51703	---	---	3.50	2.45	3.60	2.55	---	---
U.N.S.M. 51704	---	---	---	---	---	---	3.15	2.25
U.N.S.M. 51705	---	---	3.40	2.50	---	---	---	---
U.N.S.M. 51707	---	---	3.45	2.50	---	---	---	---
U.N.S.M. 51710	---	---	---	---	3.50	2.85	---	---
U.N.S.M. 51713	---	---	---	---	3.45	2.55	---	---
U.N.S.M. 51714	---	---	---	---	3.75	2.70	---	---
U.N.S.M. 51699	---	---	3.45	2.50	---	---	---	---

Measurements made to nearest .05 mm by ocular micrometer following method of Hutchison (1968). AP=distance between antermost and postermost extremities of tooth with respect to anteroposterior axis. TR=distance between lingual and labial-most extremities perpendicular to anteroposterior axis viewed normal to occlusal surface.

#### Subtribe Parascalopina

##### cf. *Parascalops*

A large, robust left humerus lacking the proximal end (U.N.S.M. 51797) is comparable with that of *Parascalops breweri* and *Scapanulus oweni* in overall shape. Although comparable in size to humeri of *Scalopus (Hesperoscalops) mcgrewi*, it differs greatly from the latter in its relatively long, narrow shaft and in the widely open notch between the teres tubercle and epicondyle. Among Tertiary fossils, the specimen most closely resembles humeri of *Domninoidea* (see Hutchison, 1968:80), but is considerably larger than any of a large sample of undescribed *Domninoidea* from the Valentine Formation in the U.N.S.M. collections. It is hoped that further collecting will uncover the dentition of this interesting mole.

##### cf. *Scalopoides*

A small, relatively unspecialized talpid is represented by (U.N.S.M. 51798) a left humerus lacking much of the proximal end. The specimen is long and slender and has a shallow brachialis fossa compared to the other mole humeri from Santee, thus suggesting a weakly fossorial habit. Humeri

of *Scalopoides* as described and figured by Hutchison (1968) most nearly duplicate the morphology observed in the Santee specimen. The known range of *Scalopoides* is Hemingfordian through Barstovian of the Great Plains (Wilson, 1960; Storer, 1975) and Barstovian through Clarendonian of the Great Basin (Hutchison, 1968). Postcranial material questionably referable to the genus is also known from three Hemphillian faunas in Oregon (Hutchison, 1968). As in the latter case, positive identification of the *Scalopoides*-like mole from Santee must await recovery of complete dentitions.

#### CONCLUSIONS

Talpid faunas from the later Tertiary of the Great Plains are not well known, particularly those of Hemphillian age. The only described and figured talpid fossils known to me from rocks of Hemphillian age on the Great Plains are a humerus from the Edson local fauna (Hibbard, 1939) and the fragmentary ramus from the Saw Rock Canyon local fauna, which became the type of *Scalopus (Hesperoscalops) seawardensis* (K.M. Reed, 1962). A humerus from the "Upper Snake Creek" beds was mentioned by Matthew (1924), but it was not described in detail. The evolutionary history of the Talpidae west of the Rocky Mountains is, in contrast, much

better known, thanks to the work of Hutchison (1968) who described no fewer than five talpid taxa from strata of Hemphillian age in Oregon.

The present study has shown that a mole fauna of comparable diversity also existed in the central Great Plains during the late Hemphillian, approximately 5 million years ago. Unfortunately, only one of the four talpids recognized in the Santee local fauna is represented by sufficient material for specific assignment. This species, described as new in the present paper, is an anatomically precocious member of *Hesperoscalops*, now recognized as a subgenus of *Scalopus*. With its fully hypsodont teeth and extremely short, broad forelimb elements, the new species was apparently well adapted to the completely subterranean niche now occupied by *Scalopus* (*Scalopus*) *aquaticus*.

#### ACKNOWLEDGMENTS

Collecting fossils invariably involves a combination of pleasurable excitement and hard labor. Karl S. Osvald and Jane Voorhies have shared with me a high measure of both in making the collection at Santee. I have benefited greatly from discussions with my colleagues in the Division of Vertebrate Paleontology, University of Nebraska State Museum. Harvey Gunderson provided access to Recent talpid skeletons. Martha Haack prepared Figure 2; the others were prepared by Jane Voorhies. Gail Littrell typed the manuscript.

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